MARTIAN AND HED MELT INCLUSION ANALYSES: COMPARISONS OF MARTIAN AND VESTAN ACHONDRITE PARENT MELT COMPOSITIONS TO TERRESTIAL MAFIC ANALOGS

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Introduction: Melt inclusions are micrometer-sized droplets of melt that are trapped within younger host minerals during crystallization from evolving melts [1,2]. Primary melt inclusions record the earliest parent melt compositions and are isolated from post-crystalliztion processes [3], while secondary melt inclusions typically record later parent melts changes [4]. Melt inclusion studies have been widely applied to terrestrial systems to discern the nature of their parent melts [2]. From the extra-terrestrial standpoint, melt inclusion analyses have been used to investigate achondrites (e.g. [3,4,5,6]), and are thus a useful tool for determing parent melts on other planterary bodies.

In this study, we will compare the petrographic features and compositions of melt inclusions from cumulate igneous rocks from three different planetary bodies: Mars, 4 Vesta, and Earth. Nakhlites are clinopyroxene-rich achondrites which originated from Martian cumulate pile(s) [5,6]. Cumulate eucrites (clinopyroxene and plagioclase-rich gabbros) and diogenites (coarse-grained orthopyroxenites) are achondrites believed to originate from 4 Vesta [7,8,9] and could be genetically related [10,11]. Layered mafic intrusion gabbros, mid-continental thoelittic basalts and ocean island basalts on Earth represent cumulates believed to sample primitive terrestrial magmas [2]. By analyzing melt inclusions from these parent bodies, we will draw comparisons of parental melts, with a focus on exploring enrichment or depletion in incompatible trace elements.

Samples & Methods: We are investigating nakhlite (NWA 11013, NWA 13669, NWA 10720), cumulate eucrite (NWA 8564), and diogenite (NWA 7831) samples currently in-hand at the Cartwright Cosmochemistry Lab (CCL) at the University of Alabama (UA), with additional samples under acquisition. We have a number of cumulate terrestrial samples in-hand that represent different terrestrial reservoirs, including Bushveld, Skaerekgaard, Theo's Flow, Hekla, and Colorado River Basalt Group mafics.

Initial petrographic observations of sample thin sections were used to determine regions of interest (ROIs, i.e. locations of melt inclusions) using the Zeiss Axio M2M petrographic microscope in the CCL at UA. A Thermo Scientific Apero scanning electron microscope (SEM) in the Alabama Analytical Research Center (AARC) at UA is being utilized to qualitatively confrim melt inclusion phases through x-ray mapping of ROIs, collected via energy dispersive spectroscopy (EDS). Initial analyses of nakhlite NWA 13669 showed glassy, crystalline, and round inclusions were present, including a large (~0.1mm) polymineralic melt inclusion with an opaque rim of constrasting composition (Fig. 1). We have also observed secondary melt inclusions in NWA 13669 (e.g., tiny transecting opaque inclusion clusters, round inclusions in fractures) and in several other samples.

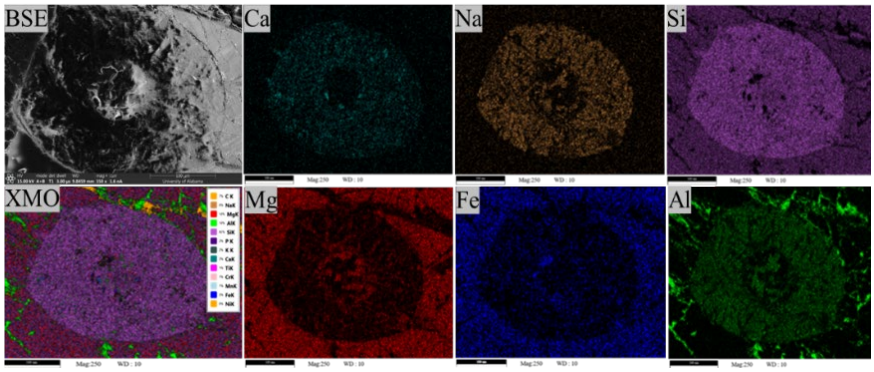

Fig. 1 –SEM-EDS images of a NWA 13669 melt inclusion. Backscatter electron (BSE) image, x-ray map overlay and major element x-ray maps included.

Future work will combine electron microprobe analysis (EMPA) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to gather quantitative compositions of melt inclusions. Afterwards, we will employ focused ion beam (FIB) milling to prepare melt inclusion samples for atom probe tomography (APT).

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